Human Nutrition Laboratory

Agricultural Research
Science and Education Administration
U.S. Department of Agriculture
Grand Forks, North Dakota

Body functions of volunteers are monitored in the clinical research unit.

Aggressive behavior of rats is studied to correlate brain chemistry with zinc levels in the diet.

Levels of several nutrients are measured in daily blood samples from human volunteers in the clinical research unit.

Rats are fed nickel-supplemented (left) and nickel-deficient (right) diets in a new trace element study.

At the Human Nutrition Laboratory, Grand Forks, N. Dak., scientists and clinicians study the role of trace elements in nutrition and how these elements sustain life, promote growth, and contribute to the health and well-being of humans and animals. Trace elements are essential nutrients present in the body in minute quantities. Until recently, however, the importance of these elements on human health has been overlooked.

To gain insight into the intricacies of trace element metabolism, scientists first conduct experiments with laboratory animals. These results are then used to plan studies for human volunteers in the clinical research unit of the Human Nutrition Laboratory or at other collaborating institutions.

Administered by the Science and Education Administration, the Human Nutrition Laboratory, on the University of North Dakota campus, is located near a medical complex that includes the University of North Dakota Medical School, two hospitals, and a clinic. Cooperative research is conducted with these institutions as well as with other hospitals and universities in the United States.

The Human Nutrition Laboratory staff includes physicians, nutritional biochemists, microbiologists, analytical chemists, a psychologist, nutritionists, dietitians, nurses, and other support personnel. Through individual and team research, their studies add to the ever-growing fund of nutritional knowledge.

Sophisticated research at the Human Nutrition Laboratory is made possible by a vast array of technical equipment. For example, the clinical laboratory of the metabolic unit contains instruments to measure nutrient levels in body fluids and tissues; a whole-body counter is available for studying the metabolism of radioactive isotopes in humans. Besides all of the apparatus required to conduct experiments at the cellular level, the laboratory is equipped with a nuclear magnetic resonance spectrometer, gas and liquid chromatographs, an amino acid analyzer, and other isotope monitoring equipment.

Zinc in Growth and Development

In living systems, zinc is absolutely essential for normal growth and development of the simplest one-celled organisms as well as the most complex mammalian creatures. Gross, adverse effects occur in humans and animals suffering from zinc deficiency.

One aspect of zinc metabolism that has attracted the attention of scientists at the Human Nutrition Laboratory concerns zinc in fetal and newborn development. A team of clinicians, biochemists, and a psychologist are studying the effects of zinc deficiency on brain development, behavior, learning, and reproduction in rats and nonhuman primates. Also, at a major university, collaborative studies are providing knowledge concerning the role of zinc in human pregnancy.

Zinc-Copper and Heart Disease

Coronary heart disease is the leading cause of death in the United States. Nutrition is a contributing factor. Although considerable controversy exists over which dietary constituents promote heart disease, people with high levels of cholesterol in their blood are the most prone.

Scientists have found that laboratory rats have high levels of cholesterol when fed a diet low in copper relative to the amount of zinc. They are now trying to determine if a similar situation exists in humans. If proven, the zinc:copper ratio hypothesis might provide some answers to the cause of coronary heart disease.

Trace Metals and Infection

When humans and animals become sick or infected, their metabolism of trace metals changes drastically. These changes seem to reflect the body's attempt to combat the cause and to point to the need for adequate nutrition to ward off disease.

Microbiologists at the Human Nutrition Laboratory are studying the metabolism of trace metals during infection in humans and animals. These experiments will provide valuable information regarding the role of trace elements in immune mechanisms, which protect humans from disease.

Intestinal Absorption of Trace Elements

To be used in the body, trace elements must first be freed from food and then passed through the intestinal wall into the blood. Intestinal absorption is a complex process, and mammals have developed sophisticated mechanisms for regulating the entrance of trace elements into the body.

Describing the intricacies involved in the absorption of trace metals is the goal of biochemists at the Human Nutrition Laboratory. Knowing about bioavailability of trace metals in food as well as understanding the absorption pathways will improve understanding of how trace metal deficiencies occur and how they can be prevented.

Clinical research or the metabolic unit of the Laboratory is closely related to the basic studies of intestinal absorption that are done in animals.

Nickel, Vanadium, and Arsenic

Now that several elements present at the parts per million level have been shown essential in human diets, scientists at the Human Nutrition Laboratory are studying elements present in tissues in parts per billion concentrations.

Nickel and vanadium and even arsenic are the subjects of investigation at the Laboratory. By feeding laboratory animals diets deficient in these elements, researchers are learning of their biochemical and physiological functions.

When the needs of these newer trace metals are established for laboratory animals, similar experiments will then be conducted on volunteer subjects.

Clinical Research

Researchers are studying human volunteers in the metabolic unit on the second floor of the Human Nutrition Laboratory. The unit includes private rooms for eight volunteers, a lounge, dining area, workshop, and kitchen, plus clinical chemistry and physiological laboratories.

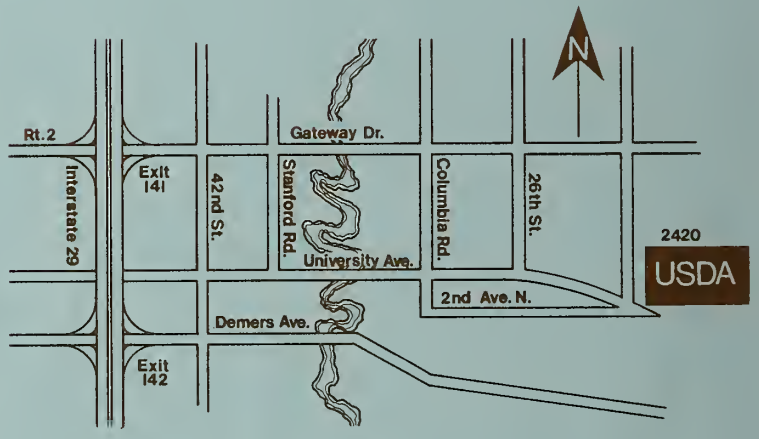
Research includes studies of the availability of mineral elements for intestinal absorption, nutrient interactions and requirements for trace elements.

In collaboration with scientists working at other ARS laboratories and scientists at universities, research is conducted on volunteers living both in and outside of the unit. These studies are designed to provide knowledge about the roles of specific nutrients and their requirements in people under different physiological conditions.

Wide Scope of Research

Although the main thrust of the research is directed toward a better understanding of the role of trace elements in nutrition, other basic food groups are not overlooked—protein, carbohydrate, fat, and vitamins are also studied in collaboration with scientists at other ARS laboratories and at universities.

In addition, scientists at the Human Nutrition Laboratory collaborate with agricultural research specialists in soil science, agronomy, food technology, and engineering. The combined efforts of these researchers is rapidly leading to a better understanding of human nutrient requirements.



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2420 Second Avenue North
Grand Forks, North Dakota 58201